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# Integrated Water Sensitive Design: Opportunities and Barriers to implementation

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## ABSTRACT

Flooding incidences are increasingly prevalent due to climate change, weather variability, building and land use practices. One of the regions to experience recent wide-spread flooding is located in the South West region in England. This region remains prone to flooding since the significant flooding of the Somerset levels during the 2014 storms. But with the growing demand for more housing in the UK and in North Somerset in particular, it is now important to review the current building and development practices for flood resilience.

The current regulations for water management in the built environment remains unclear for both new and existing development. However, this study focusses on the former and explores the potential for, and use of water-sensitive urban design (WSUD) solutions in two new housing schemes in North Somerset, South West England.

This study presents a brief overview of WSUD definitions and strategies, highlighting the corresponding opportunities and barriers to implementation. Then, primary research from documentary review and interviews of property development experts and the local council will be presented. The main drivers for WSUD were found to be led by the local authorities and regulatory bodies such as the Environment Agency. Key barriers include the up-front time and investment required to implement water sensitive design schemes. Also, mentioned were the maintenance cost and the health and safety implications of exposed water bodies in housing developments. The extended abstract concludes with recommendations to encourage better uptake of WSUD in future housing schemes.

*Keywords: Flooding, Housing schemes, Resilience, Water Sensitive design*

## 1. INTRODUCTION

Climate change is an ever-increasing reality and this has been largely attributed to human action since 1750 (Eggen & Urquhart, 2013). There has been recent research conducted by Sutton and Dong which demonstrates a link between the rise in sea surface temperature with the increased summer rainfall over Northern Europe, much like that experienced by the UK in 2012 (Sutton & Dong, 2012). Prior to the storm floods of 2015/16 in the north-west, one of the wettest winters was recorded in the southern part of the UK in 2013/14 (McKenzie, 2015). During the storms in December to January 2014, weather impacts were initially related to strong winds. However, as the rainfall levels continued to grow, the focus shifted from the wind to flooding. This included large watercourses such as the Severn and Thames but also resulted in coastal flooding in the south and west of the UK (MetOffice, 2014). A flooding event of similar significance occurred in 2000/01 and it was only after this storm event that groundwater flooding was recognized as a significant issue. These events have made flood resilience a focus of government planning, regulatory attention and academic research (McKenzie, 2015). Flood-risk management bodies in the UK have shifted the emphasis from engineered flood defences and intensive watercourse management to 'sustainable flood-risk management' (Ball, et al., 2013). This change of focus targets resilience as opposed to outright prevention.

Resilience is defined as 'the ability of individuals and/or communities to withstand and rapidly recover from a disaster such as a flood' (Ball, et al., 2013). The aim of this project is to evaluate the current state of the art of water sensitive design as a meaningful strategy for flood resilience particularly in the

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UK. It also purposes to highlight the opportunities and barriers to this integrated design approach. The qualitative case study approach is utilized because it is ideal for exploring incremental questions and developing an in-depth understanding and insight into an issue (Creswell et al., 2007). The analytic strategy is to identify issues within each case and then look for common themes that transcend the cases (Yin, 2003). The objectives of the study were:

- To review definitions, characteristics, types and methods for achieving water sensitive design.
- To present the context, state-of-the-art and key drivers for water sensitive design in the UK
- Using qualitative case studies, to investigate the opportunities and barriers to water sensitive design in the UK
- To consolidate finding and make recommendations for wider implementation in current and new housing schemes.

The results will be presented in the full paper as lessons learnt, from which recommendations are drawn for further work. The scope of this study is limited to new housing developments in the South West region of the UK. Irrespective of this, the planning frameworks and flood hazards are comparable with similar regions in the UK, and there is scope for transferable lessons to other flood risk regions across the world.

## 2. WATER SENSITIVE URBAN DESIGN (WSUD)

WSUD is the process, rather than a final condition (Institute of Civil Engineers, 2013), of integrating water cycle management with the built environment through planning and design (CIRIA, 2013). WSUD as a concept is gaining an increased amount of support as a means of urban water management through the better positioning of design processes and urban planning (Institute of Civil Engineers, 2013). This process seeks to meet people's needs but also recognises the importance of maintaining a healthy natural environment. In the UK, these WSUD features can also be known as SUDS (Sustainable Urban Drainage Systems), however WSUD is not simply stormwater management or a form of 'super SUDS' as SUDS deal with drainage alone (Institute of Civil Engineers, 2013).

The integrated design approach is required for a coherent and effective WSUD scheme. This requires complete collaboration between the government, local authorities, infrastructure providers, local communities and others (Arup, 2013). Some techniques of WSUD are: to use, reuse and exploit the management of wastewater, protecting and enhancing natural landscapes and integrating new structures and features by the use of water. Some other forms of WSUD could be reducing the demand for potable water by harvesting rainwater from roofs and wastewater reuse, minimising wastewater generation from properties and the treatment of wastewater so it can be either be reused or discharged into a local watercourse without polluting it. It also brings 'sensitivity to water' into urban design as it ensures that water is considered from the outset of the design process (Institute of Civil Engineers, 2013). An effective WSUD scheme brings together a variety of disciplines of design, engineering as well as environmental sciences to protect watercourses and aquatic environments.

Water Sensitive Urban Design (WSUD) can be categorised into three scales which are suited for both researching and for 'good practise'. These three scales of WSUD are: macro, meso and micro (Ellis, 1999). Some general key elements for mainstreaming WSUD are shown below in Figure 1.

Level	General key elements
<b>Macro</b>	<ul style="list-style-type: none"> <li>• Climate</li> <li>• Urban growth</li> <li>• Socio-political capital and sustainability</li> </ul>
<b>Meso</b>	<ul style="list-style-type: none"> <li>• Attitude of stakeholders</li> <li>• Knowledge and trust</li> <li>• Complexity of stakeholders</li> <li>• Co-operation, involvement and communication</li> <li>• Regulation, guidelines, agreements and contracts</li> <li>• Cost and cost allocation</li> </ul>
<b>Micro</b>	<ul style="list-style-type: none"> <li>• Added value</li> <li>• Enthusiasm of individuals</li> <li>• Location characteristics</li> <li>• Construction, operation and maintenance</li> </ul>

**Fig. 1. Key elements of the different scales of WSUD (Rijke et al., 2008)**

Cooperation between these levels is a fundamental requirement for successful, integrated and adaptive water management (Pahl-Wostl et al., 2008).

- 'Macro' scale refers to an entire city (or majority of one) and will involve large water management facilities.
- 'Meso' scale is of a smaller proximity to that of the 'macro' and will focus more on an urban block and neighbourhood.
- 'Micro' scale focuses on the individual building. (Ellis, 1999)

## **2. METHODOLOGY**

The qualitative case study methodology was used, with interviews as the primary data collection method. The case study methodology allowed for the subject and key players to be fully studied within its context. Interviews can be adapted to be a flexible method of data collection and so the type of interview chosen influences the practical aspects of the interview (Punch, 2005). There are three main types of interviews: an informal conversational interview, the general interview approach and standardised open-ended interviews (Patton, 1990). A general interview approach was taken and once the data was collected, the process of 'data reduction' (Punch, 2005) began to reduce the quantity of data without significant loss of information, ensuring the results were not taken out of context.

**Case Studies:** The case study compares two housing developments in North Somerset. This area of the South-West England region was chosen due to being at high risk to flooding and also due to the Council's plans to construct 5500 new homes by 2020. The selected ongoing developments are two of the biggest projects in this area with completed and on-going phases on site. Both of the house-building companies have differing target markets making the comparison of the use of WSUD possible.

**The method:** Two interviews were conducted with the project managers of the two development sites. Each interview duration was approximately 60 to 90 minutes and the data recorded using a Dictaphone. The interview questions and full findings will be detailed in the full paper. Both interviewees have been involved in the house-building sector for the majority of their careers. Following an interview with each of the project managers, a site ethnography was permitted and conducted and photographic records were taken. A telephone interview was also conducted with a Flood Engineer in North Somerset Council. This was to: expand on the planning approval process outlined by the project managers, to give an insider's perspective on the drivers and implementation of WSUD in new developments. This phone interview also supplemented other documentary data provided by the council.

## **3. SUMMARY OF FINDINGS**

The case studies provided good insight into the state of the art of WSUD in developments in the UK. Both developers had different target markets, one aiming for young families who were first-time buyers (low-end of the market) and the other targeting the middle-income market i.e. young professionals buying their second or third home and who have a larger budget. This reflected on the attention and resources used for communal WSUD features on the site. However, both developments used a significant amount of WSUD including multiple rhynes (Somerset term for drainage ditches or canals) and swales that were used to enhance the aesthetics of the site.

It was found that the policy tools and regulations were the main drivers for considering WSUD in housing developments in the UK. The main advocates were also found to be the Environment Agency and local authorities. These governing bodies have set requirements for the careful discharging of surface water collected from impermeable surfaces such as roads, pavements, driveways and roofs. Usually local authorities may not have as much focus on resilient design. However, this case examples showed that there are considerable benefits; including social-economic benefits, if the local council takes a proactive approach towards flood resilience. The planning approval process can be time and resource intensive. This remains a considerable factor also in this case where it was found that the negotiations for the implementation of WSUD extended the planning process even further for both case study sites. This was predominantly due to the sensitivity of the area and its location within a floodplain and also that the developers had to meet additional requirements such as generating at least 1.5 jobs per new house to be built, but also required that these employment opportunities had to be in place before house building

could start. This additional requirement was to bring work to the area and reduce commuting outside of the immediate area, but still had implications in terms of time, resources and cost.

A common point raised by the developers was that these WSUD features would require future maintenance. The cost of maintenance compared to hidden drainage and infrastructure could be barrier. Also, access to the rhynes is required for regular maintenance which means that no fencing can be fitted to prevent cars or people falling into the watercourses. Therefore, these features could raise some health and safety concerns. Integrating natural water features into the housing developments have clear benefits but there is also the need to engage with residents to increase the awareness of this benefits. This will help to justify additional maintenance costs e.g. through services charges but also help to improve safety behaviours around WSUD features.

#### **4. CONCLUSION AND RECOMMENDATIONS**

The UK has made positive and encouraging changes to regulations and requirements for WSUD in housing developments, particularly if they are located within a floodplain or area of high flooding risk. From the case studies, it is clear to see that the uptake on WSUD is on the rise and the design of housing developments has significantly improved due to the need for better flood resilience. However, there is scope for more to be done especially at the individual housing scale. The general layout of an individual house remains largely the same so there is scope to extend regulations to spatial design and tectonics as well.

The main drivers for WSUD at present are the local authorities and regulatory bodies such as the Environment Agency. Therefore, there is still need for building professionals and developers to take the initiative in building and built environment resilience. This can be achieved through even better regulations and incentives. It was also found that the compliance framework and strategies for Flood and Water Management within the act could vary per region and local authority. Therefore, more detailed guidance is still required to make it easier for other local authorities to implement WSUD in new and large scale housing developments.

Lastly, a forward-thinking recommendation would also be that mechanisms including funding, grants and incentives should be put in place to ensure the maintenance of WSUD features such as rhynes and swales to ensure their continued functionality and efficiency in the longer term.

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